International Journal of Mechanical and) Production
Engineering Research and Development (IJMPERD)
ISSN(P): 2249-6890; ISSN(E): 2249-8001
Vol. 9, Issue 4, Aug 2019, 1269-1274

THE MICROSTRUCTURE AND CHARACTERIZATION OF TiN COATINGS PREPARED BY PHYSICAL VAPOUR DEPOSITION (PVD)

N. LENIN RAKESH[1], Dr. K. BALASUBRAMANIAN[2], J. ROSHAN[3], R. SARVANA KUMAR[4] & S. RAJ PRAKASH[5]

[1]*Assistant professor, Bharath Institute of Higher Education & Research, India*

[2]*Professor, Bharath Institute of Higher Education & Research, India*

[3,4,5]*Student, Bharath Institute of Higher Education & Research, India*

ABSTRACT

Titanium nitride (TiN) possesses excellent property as corrosion resistance, aesthetic appearance and so on. Titanium nitride (TiN) is being used for coating materials on SS, Mild steel. Since many techniques are there amongst, reactive DC magnetron sputtering has many advantages to deposit ceramic coatings using metallic targets.

In the present work, our main aim is to improve the hardness of mild steel. The titanium of 2'' diameter and 3 mm thickness is used as a target (99.99 % purity) for the deposition of TiN coatings. The micro structural, mechanical and wear properties are investigated using XRD, SEM, Vicker hardness tester and pin on disc respectively.

KEYWORDS: TiN Coatings, Microstructure & Corrosion Properties

Received: May 13, 2019; **Accepted:** Jun 03, 2019; **Published:** Jul 29, 2019; **Paper Id.:** IJMPERDAUG2019132

Original Article

1. INTRODUCTION

Table 1.1: Properties and Structure of Tin

Chemical formula	TiN
Crystal structure	Cubic
Thermal expansion coefficient	9.35×10^{-6} K^{-1}
Melting point	2,930 °C
Hardness	1800-2100 HV

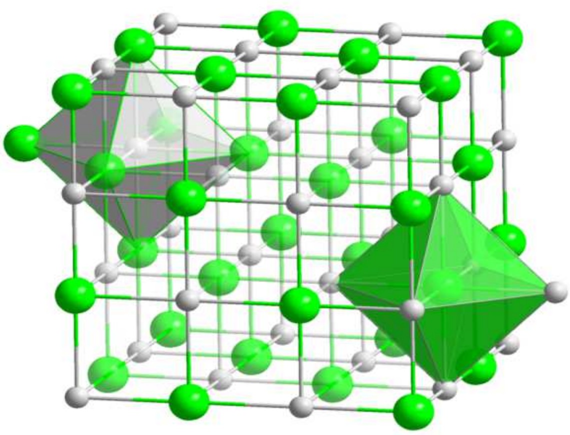

Figure 1.1: FCC Structure of the Tin

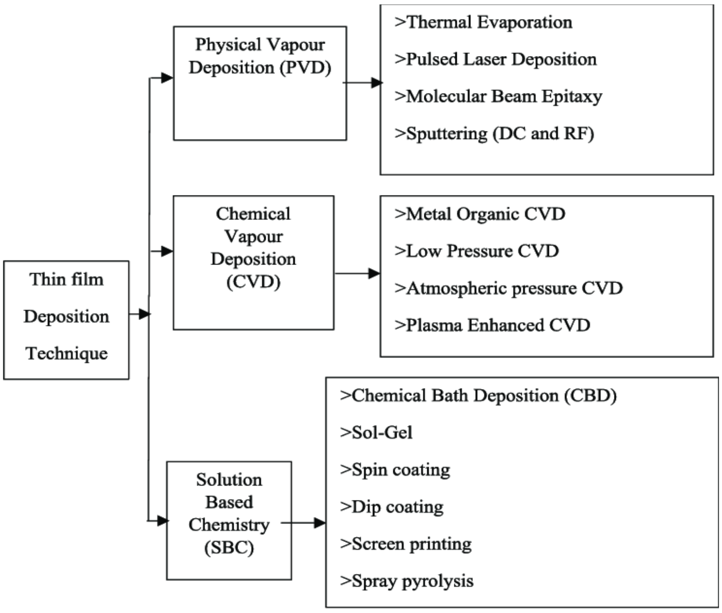

Figure 1.2: Classification of the Most Common Deposition Techniques

2. EXPERIMENTAL DETAILS

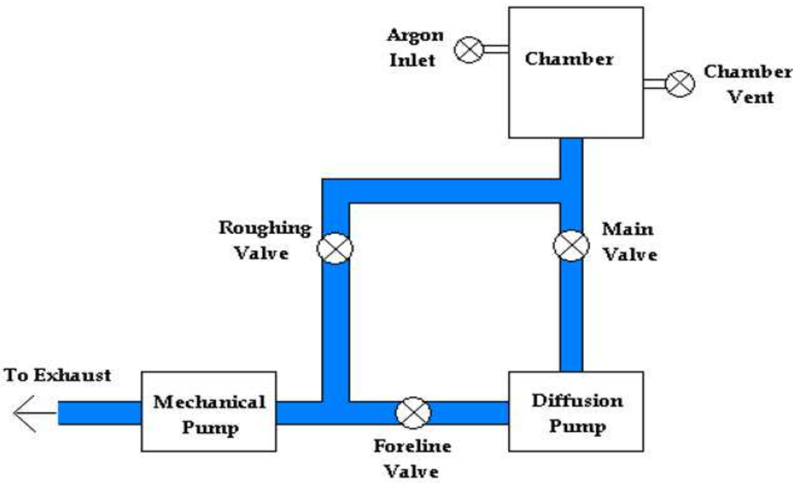

Figure 2.1: Schematic Diagram of the Sputtering Unit

3. SPUTTERING PROCESS

In this case of sputter, the deposition is we eject a material from a stipulated point, a source and later on added on to such as a metal substrate

Sputtering Process

During sputtering process the Sputtering starts when a negative charge is applied which then on to the target material causing a plasma or glow discharge.

Hence the Positive charged gas ions are generated in the plasma region and gets attracted to the negatively biased target plate. Here the collision creating a momentum transfer and later ejects atomic size particles form the target.

So on these particles traverse the vacuum chamber and are deposited as a thin film on the surface of the substrates.

As more and more atoms coalesce on the substrate, they begin to bind to each other at the molecular level, forming a tightly bound atomic layer. Here we allow more than one layer which is created for the actual production of thin film structures.

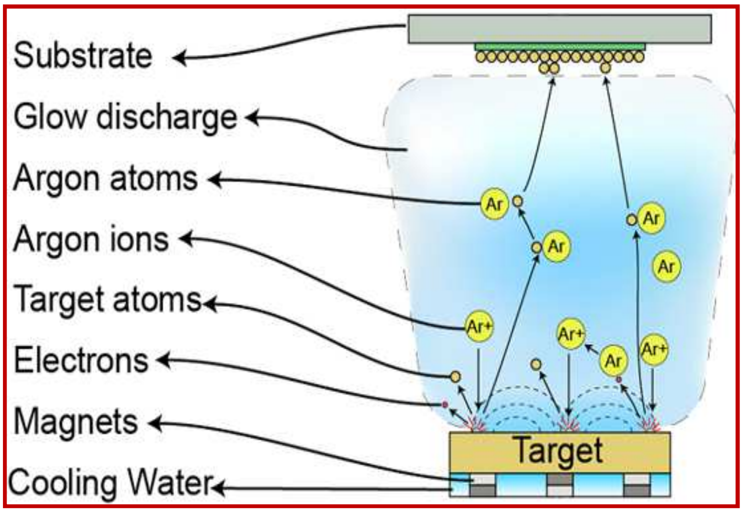

Figure 2.2: Principle of Sputtering

3.1 Deposition Parameters

- DC Power
- Argon gas pressure
- Target-substrate spacing
- Ambient gas/pressure
- Substrate temperature

3.2 Deposition Conditions

DC Power	: 400V, 0.2 Amp
Argon flow rate	: 30 sccm
Nitrogen flow rate	:10 sccm
Substrates	: MS
Substrate temperature	: RT, 250 & 500°C
Deposition time	: 1 hour
Target	: Titanium
Base vacuum	: 3.0×10^{-6} mbar
Deposition pressure	: 5.0×10^{-3} mbar
Substrate to target distance	: 80 mm

3.3 Experimental Procedure of Wear Test

Here in this experimental procedure of wear test pin being held on a disc.

The following parameters are load, speed and distance are the three parameters, such that basically the pin and then the disc are cleansed thoroughly before the actual starting of the experiments.

Figure 3.1: Pin in Disc Wear Test Rig

4 RESULTS AND DISCUSSIONS

4.1 Thickness Measurement: Dektak Profilometer

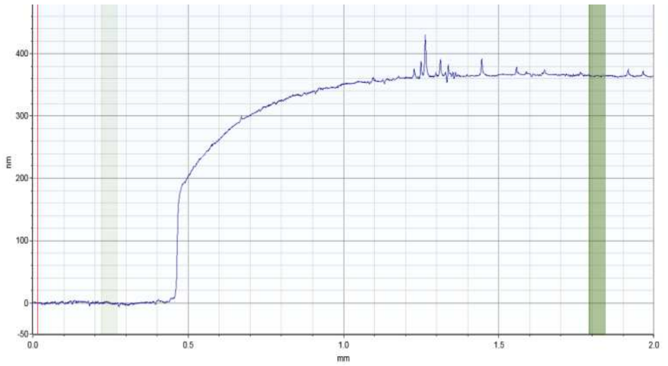

Figure 4.1: Thickness of the Tin Coating

Dektak profilometer is capable of measuring step heights between 100 Ǻ and ~50 microns with a resolution of 10 Ǻ [43]. The thickness of the TiN coatings on silicon is measured by using the Stylus profilometer and is found to be in the range 300-350 nm.

4.2 X-Ray Diffraction (XRD)

The angles 45.26°, 46.15°, 52.3°, 42 and 76.0°, corresponding to (111), (200) and (220) reflections indicated formation of polycrystalline tetragonal structure of TiN thin films. X-ray diffraction datas tells sample containing Titanium nitride in face centered cubic structure (PDF 38-1420). Here the intensity of the peaks denotes the increased crystallinity.

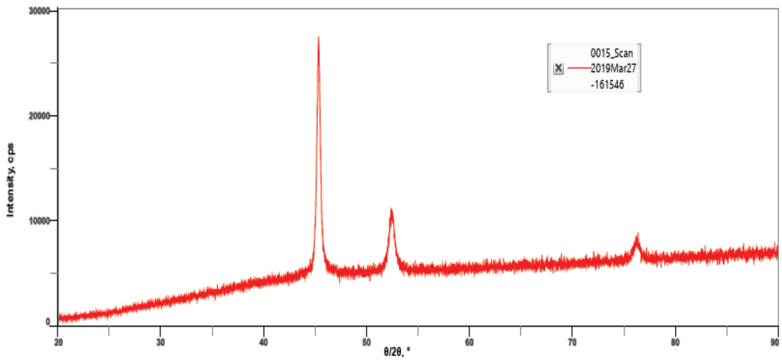

Figure 4.2: XRD – TIN Film-500°C

4.3 SEM

Scanning electron microscopy is used to characterize surface topography of the sample. The morphological study is very important for the films to observe the changes in the microstructure. Figure show the SEM image, indicating the surface topography of the TiN nanostructured thin films.

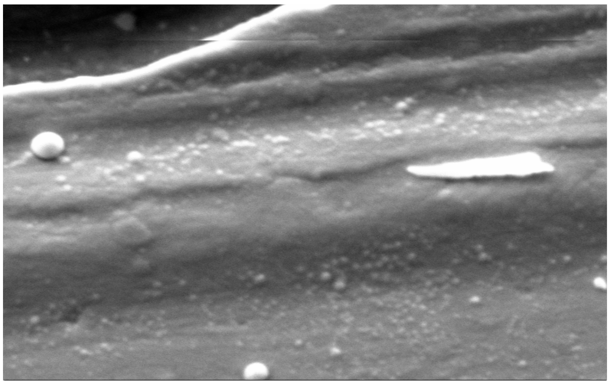

Figure 4.3: SEM Image

Figure 4.4: Wear Test of the Tin Film Deposited at 500°c Temperature

5. CONCLUSIONS

The Titanium nitride films which are deposited at different temperatures were investigated in this work. The XRD, SEM, micro indentation and pin on disc methods were employed to characterize the micro structural and mechanical properties of the films. Results shows the mechanical and wear properties of TiN films. XRD studies indicated the formation of polycrystalline TiN with fcc structure. The SEM studies show the formation of the crystallites with uniform distribution. The increase in the hardness values of TiN films with the increase of temperature was attributed to the dense and fine grain structure. The COF is reduced at the higher deposition temperature.

REFERENCES

1. *Hugh O. Pierson (1996). Handbook of refractory carbides and nitrides: properties, characteristics, processing, and applications. William Andrew. p. 193. ISBN 0-8155-1392-5.*
2. *Stone, D. S.; K. B. Yoder; W. D. Sproul (1991). "Hardness and elastic modulus of TiN based on continuous indentation technique and new correlation". Journal of Vacuum Science and Technology A. 9 (4): 2543–2547. doi:10.1116/1.577270.*
3. *Toth, L. E. (1971). Transition Metal Carbides and Nitrides. New York: Academic Press. ISBN 0-12-695950-1*
4. *"Wear Coatings for Industrial Products". Diffusion Alloys Limited. Retrieved 2013-06-14.*

5. *Pande, P. P., & SAMBHE, R. U. (2017). Artificial Intelligence Machining Predictions by Fuzzy GUI For Inconel 718 with PVD Coated Carbide Cutting Tool. International Journal of Mechanical and Production Engineering Research and Development (IMPERD), 7(3), 313-320.*
6. *"Coatings". Coating Services Group, LLC. Retrieved 2009-06-25.*
7. *"Titanium Nitride (TiN) Coating". Surface Solutions Inc. June 2014.*
8. *"Products". IonFusion Surgical. Retrieved 2009-06-25.*
9. *Dziura, Thaddeus G.; Benjamin Bunday; Casey Smith; Muhammad M. Hussain; Rusty Harris; Xiafang Zhang; Jimmy M. Price (2008). "Measurement of high-k and metal film thickness on FinFET sidewalls using scatterometry". Proceedings of SPIE. International Society for Optical Engineering. 6922 (2): 69220V.*
10. *M. Birkholz; K.-E. Ehwald; D. Wolansky; I. Costina; C. Baristyran-Kaynak; M. Fröhlich; H. Beyer; A. Kapp; F. Lisdat (2010). "Corrosion-resistant metal layers from a CMOS process for bioelectronic applications" (PDF). Surf. Coat. Technol. 204 (12–13): 2055–2059. doi:10.1016/j. surfcoat.2009.09.075.*
11. *Reddy, T. T. Corrosion and Wear Behavior of Aluminum Alloy Hybrid Metal Matrix-A Review.*
12. *H. Hämmerle; K. Kobuch; K. Kohler; W. Nisch; H. Sachs; M. Stelzle (2002). "Biostability of micro-photodiode arrays for subretinal implantation". Biomat. 23 (3): 797–804. doi:10.1016/S0142-9612(01)00185-5.*